Electric Vehicles Challenges, Opportunities, and Future Scope: The Recent Review

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1 Introduction

Supreme uses of fossil fuels in the production of electricity and various objectives like automotive industries result in a decrement in reserves of fossil fuels, consistently. Thus, relevant alternatives like renewable resources are demanded most widely. For now, the replacement of fossil fuel with electricity by automotive industries as modern technology for vehicles [1]. Therefore, electrical energy is used as a driving tool for modern vehicles as a better option to overcome conventional drawbacks. Electric Vehicles were used at the beginning of the twentieth century and taken into consideration over the decades, mainly in the U.S. [2]. A few days later, even though the status of EVs in the market was enough superior, the procedure terminated and there was dramatically increment in the use of conventional vehicles [3]. Lower acceleration, higher cost, and short driving ranges of electric vehicles were some extent reasons for the reduction of EVs and promoted the development of the conventional vehicle [4]. Making use of electric vehicle planning took up to overcome a part of challenges in major automotive industries [5].

2 Market Structure

On the authority of demands and regulations, several market frameworks are planned in various countries. In case, independent system operators (ISOs), utility companies, and generation companies create a market framework in the United States. The owner of the market framework is an independent system operator in the US. According

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to Europe, there is an almost similar market framework, but the only difference is the independent market operator [6]. Different countries having different market structures can be found in [7, 8]. In Europe, the classes of market structure depend on mandatory provisions, bilateral market, hybrid market, organized market, free offer, mandatory offer, and mandatory provisions with eliminating reservation. For instance, transmission system operators (TSOs) and a grid customer negotiate a bond for a price system and proposed service in a market that is bilateral [9].

There is a scheme for market framework at the distribution level for services like voltage regulation and congestion management by controlled operation of active power [10]. Yet, there is no scheme on segments such as load shifting, valley filling, and peak shaving. Till now, reactive power supports have not been discussed regarding commercial markets, the evaluation of economic incentive on active power support only. A lot of work conveys voltage regulation services and loading by modulation of active energy of electric vehicles. Yet, such services might not be followed by some of the EVs users by the reason of delay in the process of charging, which results in their consolation [11]. In respect of reactive power support, the use of EVs causes voltage regulation due to the injection of reactive power into the grid, it may be in high potential. The charging phenomena of electric vehicles are not influenced by reactive power, and this is one of the causes that continues users' consolation.

The market layout is a dormant concern for advanced studies regarding EV-Distribution System Service as long as acquired services from the different groups are not being allowed by nearly all of the Distribution system operators, yet [11]. Active and reactive electric vehicle distribution system services are enabled by the design of the recent markets.

3 Economic Aspects

Various researches concern on EV strategy orderly to show voltage and loading issues, eliminating the features of economic aspects, for example, the interest for dispensing resources to the Distribution System Operators (DSO). One of the viable causes might be that those analyses are mainly based on the regulation scheme, socio-economic, and environmental situations of different countries. Although, many kinds of research concentrated on strategy development, method of working, and algorithm for EV charging strategy while profitable aspects for EV-DSS are disregarded. Defining the price signal concerning the economic angle of EV-DSS is the major problem, ensuring results satisfy every stakeholder.

In Denmark, as per results of simulation executed in [12] employing actual distribution system, customers of EVs may not get sufficient profit per annum for imparting assistance to the distribution system operators, surveying single charging phenomena per EVs per solar day. Regarding the DSOs, evaluation of profit is not straightforward to compute as different groups participated in the retail market of electricity with analogous to revenue distribution. For instance, in Denmark, the injection of reactive power into the grid is abled by chargers of EVs [13]. Therefore, many kinds of research on such a point are strengthened for undertaking to answer the different question which is still disputed. Estimation of economic containing aspects like possible remuneration strategies for service providers and benefit analysis for all stakeholders are still open for further analysis.

4 Reliability Aspects

As demands for electric vehicles increase in the market, car manufacturers have remodeled their plans and policy. Reliability assessment is one of the major unsympathetic issues regarding electric vehicles, which is classified into two sub-division, i.e., reliability appraisal of recent electrical network with EVs and reliability appraisal of the internal structure of electrical vehicles [14]. The reliability appraisal of the intramural structure of EVs is criticized in this paper. Manufacturer's, seller's, and customer's perspectives to be included for the estimation of the reliability concept. Important points which are mentioned above regarding reliability assessment play a vital role in setting up an lifetime operation of electric vehicle's integrant containing electronics converter, motor drives, and battery pack [20]. Nowadays, malfunctioning, breakdown of electrical components, and imperfection in battery capacity for nearly 54% of all vehicle failures are the most dominating parameter regarding reliability conception for electric vehicles integrant [15, 16]. Accordingly, the safety of the electrical unit of EVs and improvement in reliability are required by the market. Safety and reliability enhancement will be challenging aspects due to various sub-elements of EVs. The following elements should be taken into consideration to a superior appraisal of reliability:

4.1 To display the elements of a system, parametric models were used in the traditional methods [17]. Even so, the theory that reliability features attend to probability distributions is commonly disregarded. Therefore, the operation may not be assured.

4.2 The conclusive decline logic system was implemented, which neglects the unwanted gates in traditional reliability methods [18]. Of course, environmental conditions might cause hidden failure mode in the EVs integrant model resulting in the logic gate being fairly noisy. In this way, the results of failure logical structure set off unpredictable.

4.3 Use of traditional techniques to evaluate the quotient's reliability applying the constant logical composition described by professionals [19].

5 Charging Infrastructure

As stated by the International Council for Clean Transportation, requirements of the advanced charging station and enhancement in the workplace should be implemented by 400 % in the upcoming five years. In this way, projections of EVs in large numbers will be on the road. The requirement for charging stations is increasing in large proportionally because of the higher population as well as positive results of EV adoption. In Los Angeles, 35000 additional chargers will be demanded which is seven times that were installed in 2017. City leaders sacrifice the parking zone of a conventional vehicle to develop the charging infrastructure for EVs. 2/3 of U.S. mayors are agreed according to a survey of Boston University regarding the approved proposals. The initial cost is a very challenging task about the infrastructure. According to the Rocky Mountain Institute, the installation cost of a charger is nearly three to five times the cost of chargers themselves. Various issues can be focused on during installation including building constructions. The research by Pacific gas and electric observed that installing charging capacity throughout the construction may minimize the fare per EVs charging area by approximately 75%. Developers have their intention over such an issue and guidelines for comprising charging ability in high locality area and merchandise are involved in assigned modification to the International Energy Conservation Code.

6 Battery Technology

Lithium-ion battery technology incorporates a group of chemistry that commissions different types of combinations using anode and cathode material. The most outstanding technology for electric vehicle applications is lithium-nickel-cobalt-aluminum (NCA), lithium-nickel-manganese-cobalt (NMC), lithium-manganese spinel (LMO), lithium titanate (LTO), and Lithium-iron phosphate (LFP). Lithium-ion battery technology can be compared along six dimensions as shown in Fig. 1, i.e., safety, performance, life span, cost, specific power, and specific energy. Still now, the cell has not the technology to win all six parameters simultaneously. Some of them may be high and some parameters may be small. From a business point of view, higher cost remains a crucial issue.

6.1 Cathode Materials

- **Lithium-Iron-Phosphate (LFP)**: The cost of raw material is less in the manufacturing of cathode using lithium with a large amount of phosphorous and iron. The cell is costly in terms of cost/kWh because of lower capacity as well as lower voltage inherently.
- **Lithium-Nickel-Cobalt-Aluminum oxide (NCA)**: The material used for the manufacturing of cathode has higher energy. Nowadays, the main focus is to enhance the energy density using a higher content of nickel as well as minimizing the usage of cobalt to lower down the cost/kWh. Tesla uses NCA most widely.
- **Lithium-Nickel-Cobalt-Manganese Oxide (NCM)**: The content of nickel, cobalt, and manganese in equal proportion is beneficial for excessive power

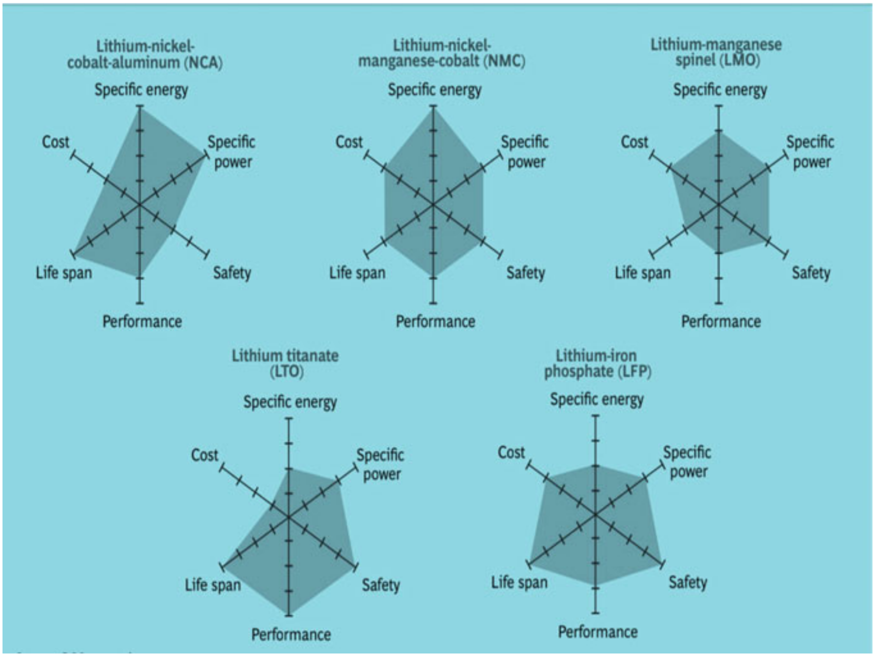

Fig. 1 Tradeoff among the five primary lithium-ion battery technologies

demands. The content of nickel is kept higher to enhance the energy density and at the same time reduce the dependency on cobalt. Nowadays, the better option for cathode materials is nickel, cobalt, and manganese with lithium in the production of all EVs.

- **Lithium-Manganese Oxide (LMO)**: LMO has similar property as LFP because it may also provide power in a large amount. While there is a lack of energy density. Lower stability is the disadvantage of such a cathode.
- **Lithium-Cobalt Oxide (LCO):** The cells have larger volumetric energy density. While power density, as well as cyclic capability, is quite low using LCO. The cost will be a larger issue if the cathode is mainly made of cobalt.

6.2 Anode Materials

The selection of anode is mainly based on carbon because it is cheaper and has higher energy ability. But they have less voltage v/s lithium ions. Nowadays, the popular technology regarding anode material is based on carbon. It may be altered with innovative ideas including fresh lithium and fresh silica anode. The charging phenomena of anode containing lithium titanate oxide will be extremely fast. Therefore, the cells can show a full charge in nearly five minutes. The initial cost is quite higher. Also, they have a low energy capacity.

7 Service and Maintenance Support

Even if, electric vehicles have known for not so great maintenance and also not to need so much repair. Still, it is important to find professional mechanics in the required field. Woefully, more than 90% of mechanics are not chartered to work on electric vehicles. On the other hand, the remaining of them work for dealerships. Even if a large number of hybrid vehicles are available in the market, the requisite maintenance regimes are similar to conventional gas-powered vehicles. It may explain that for persons who have been certified for working on hybrid vehicles, it may not necessary to know about every single-electric model. Woefully, there is a lack of maintenance support and infrastructure (charging station) for electric vehicles but it will be demanded more in the future. Electric vehicle owners have a few options for professional mechanics. Greatfully, electric vehicle owners need not search for their mechanics because their vehicles have lesser fluid (such as transmission fluid and oil) and also have limited moving parts.

8 Future Energy Consumption

Here, analysis in detail has been done to predict energy utilization in the future if the automotive is electrified. If the charging phenomena would be taken place, then that will smash electrical system infrastructure. Governments have a proposal with aim of 20–30% of EVs in the market that replies huge energy utilization would be needed. The analysis is performed in Table 1 considering battery capacity and Wh/km. The available data describes the mean of the different classes by a different manufacturer in the market. Scenarios of 20%, 30%, and 100% are grabbed by observing the different extent of evolution regarding EV. The average distance traveled by two-wheeler is 20 km/day, three-wheeler travels 80 km/day, four-wheeler travels 100 km/day while the commercial vehicle travels 250 km/day are taken for consideration [21].

Table 1 Different types of vehicles and their battery specifications

Type	Battery(kWh)	Range(km)	Wh/km
Commercial	32	156	195
Four-wheeler	32	156	195
Three-wheeler	1.1	85	13
Two-wheeler	1.2	70	18

Energy utilization per day for different percentages of EVs is discussed in Table 2. It may be concluded that energy utilization per annum is 14TWh/year for 20%, 22TWh/year for 30%, and 75TWh/year for 100% EVs use.

9 Electric Vehicle Grid Integration and Future Development Trend

Electrification in the transport sector has considerably obstructed the traditional business model of the electrical system. In general, EVs have led both merits and demits for the distribution grid including several challenges. The distribution grid can be influenced by the following factor such as load profile, voltage and frequency imbalance, stability, and harmonic injection due to excessive integration of electric vehicles. While excessive penetration may lead to issues like power regulation and power quality [22]. EVs can work as electrical load (G2V), working as an energy source for other EVs (V2V), energy storage system for buildings (V2B), and energy storage system for the grid (V2G), which differs in function from transportation tools. Various technologies are introduced within the automobile sector which results in growth and effectiveness toward the use of the distribution grid. Wireless Power Transfer (WTP), autonomous driving, and connected mobility (CM) come under modern technologies and will be revolutionized in the future. The link between vehicle to vehicle, vehicle to the passenger, vehicle to a traffic signal, etc. such an idea represents the concept of connected mobility. EVs may take part in the growth of energy internet technology [23]. The concept of EI represents the energy conversion of cooling and heating using chillers and boilers to organize the definite power, gas, transportation, and thermal system in a unique policy [24].

10 Conclusion

This paper presents a review of some recent researches concentrating on future scope and challenging aspects regarding electric vehicles. Some modifications would be required in the market structure like different countries should have some similarity index to operate in a parallel manner. Organizations may require some changes in their plan and policies so that users get motivated toward EVs. Advance infrastructures like flash Charging stations, battery swapping systems, and qualified mechanics in large numbers are still demanded. Battery technology that can be utilized using six dimensions to optimize the performance is discussed. Also, the description of the reliability concept and prediction of future energy consumption are explained above. However, further development and research are still needed to overcome the various problems regarding the electric vehicle.

Table 2 Energy utilization per day for different percentages of EVs

	Outline of 20% EV in 2030			Outline of 30% EV in 2030			Outline of 100% EV in 2030		
Type	20% EV	kWh/km	kWh/day	30% EV	kWh/km	kWh/day	100% EV	kWh/km	kWh/day
Commercial	262203	51130	12782500	393304	76694	19173500	1311013	255648	63867000
Four-wheeler	1310189	255487	25548700	1965284	383230	38323000	6550945	1277434	127743400
Three-Wheeler	246762	3208	256640	370144	4812	384960	1233812	16040	1283200
Two-Wheeler	7921479	142587	2851740	11882218	213880	4277600	39607394	712933	114258660
Total	9740633	452412	41439580	14610950	678616	62159060	42152219	2262055	307152260

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